DOCUMENT RESUME

ED 080 174 PS 006 658

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TITLE Operant Conditioning of Visual Fixation in Infants Under Three Intensities of Auditory and Visual Reinforcement.
SPONS AGENCY California Univ., Berkeley.
PUB DATE [71]
NOTE 7p.; An earlier version of this paper was presented at the biennial meeting of the Society for Research in Child Development (Minneapolis, Minnesota, April, 1971)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Aural Stimuli; *Eye Fixations; *Infant Behavior; *Learning Processes; *Operant Conditioning; Reinforcement; Response Mode; Sex Differences; Technical Reports; *Visual Discrimination; Visual Stimuli

ABSTRACT

Visual fixation on one of two blank targets was reinforced with either visual or auditory stimuli in one of 3 intensity sequences: (1) low, medium, high; (2) medium, high, low; and (3) high, low, medium. An analysis of variance of learning scores for the 48 14-week-old infants resulted in a significant interaction of intensity and order and in a significant interaction of sex, modality, intensity and order. These results are discussed in terms of the infant's sensitivity within particular learning situations. (Author)

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Abstract

Visual fixation on one of two blank targets was reinforced with either visual or auditory stimuli in one of 3 intensity sequences, 1) low, medium, high 1) medium, high, low, and 3) high, low, medium. An analysis of variance of learning scores for the 48 14-week-old infants resulted in a significant interaction of intensity and order and in a significant interaction of sex, modality, intensity and order. These results are discussed in terms of the infant's sensitivity within particular learning situations.

Operant Conditioning of Visual Fixation in Infants Under Three Intensities of Auditory and Visual Reinforcement[1]

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A previous study (Watson, 1969) examined the usefulness of the fixation response in infants as an appropriate vehicle for the study of operant learning. That study also determined whether auditory as well as visual stimulation could serve as reinforcement. The auditory stimulus was a 1000 cps tone of approximately 65 db, and the visual stimulus was a red light of approximately 28 ft. candles from behind a translucent circle which displayed a schematic face. In each of the two experiments, one with 14-week-olds and one with ten week olds, visual fixation did show significant effects of operant learning. However, there appeared to be a sex difference in learning which interacted with the type of reinforcer. In general, female infants learned better under auditory reinforcement than under visual reinforcement and males learned better under visual than under auditory. Given the later age sex difference findings that girls generally excel on verbal tasks and boys on spatial tasks (Maccoby, 1966; Terman and Tyler, 1954) this finding was viewed as quite interesting.

Watson concluded that his results were most simply explained by an assumption that the sexes differ in their responsiveness to the visual and auditory modalities. He also proposed an alternative explanation which incorporated the possibility that the two stimuli used may have functioned differently because of a difference in their relative intensity levels rather than because they differed in modality. The observed interaction might really be an interaction of sex and intensity. If so, then altering the intensity of the stimuli would be expected to change the potential reinforcement value of stimuli in each modality. If the original stimuli had differed in intensity and the sexes of this age differ in arousal thresholds then perhaps a softer tone would support learning for males or perhaps a brighter light would support learning for females.

The intensity variable in reinforcers was employed in this study, using the same apparatus as in the earlier Watson study. An operant procedure was used but in addition to the one intensity of the light and tone previously used, a greater and a lesser intensity of both light and tone were included.

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Method

Subjects

Forty eight full-term infants, 24 male and 24 female, were solicited from the birth records for the city of Berkeley, California. All were home-reared infants and all but one were caucasian. The infants were within one week of 14 weeks of age when tested.

Procedure

The subjects were brought to the laboratory room at the Institute of Human Development by their mothers. The room was dim and contained a special bassinet described earlier by Watson (1969). In supine position within the bassinet, the infant could see two three-inch white circles on a black background approximately one foot overhead. When the infant visually fixated one of the circles, the left or the right, he could be reinforced for doing so by either seeing a red light come on behind the translucent circle or by hearing a tone delivered through a speaker at midline at the head end on the bassinet. The visual reinforcement was a red light of either 9, 28, or 110 ft. candles on a background of .11 ft. candles as measured from the angle of regard. The auditory reinforcement was a tone of 1000 cps at either 50, 65, or 80 db on a background of "silence" as measured at the position of a subject's ear. There was no schematic face incorporated in the visual reinforcement in this study. Each infant was in either the auditory or visual reinforcement situation.

The infant's reinforcement group was unknown to the observer. This control for observation was accomplished by having the observer look through a green filter which blocked out the red lights and hear a tone of 1000 cps delivered through earphones which masked out the tones. The selection of which circle would be designated as correct for a particular subject as well as which modality was to be reinforced and in what order was made by an assistant.

The observer recorded the fixations of the infants by observing which circle was reflected in the pupils and moving a toggle switch to indicate the appropriate side. Center position of the toggle switch was used to record all off target fixations.

In a conditioning period, when the recording switch was positioned to the correct side, the reinforcement would come on and stay on for a maximum of three seconds of the infant chose to fixate for three seconds or longer. The reinforcement went off automatically at the end of three seconds or with the cessation of a fixation before the three second limit.

The conditioning procedure is different from that originally used by Watson (1969). In the present study, all conditioning periods were based on a specified number of rewards rather than on a specified amount of time. During the baseline period an infant had to look five times at the "to-be-rewarded" side before the period ended and the first conditioning period began. The first conditioning period ended when the infant received five reinforcements. The extinction period ended when the infants fixated the previously rewarded circle five times. The next two conditioning and extinction periods were the same. This insured that all infants were reinforced the same number of times under each intensity. There were five rewards for each intensity or 15 rewards for the total procedure.

The subjects were balanced across conditions, half of the females and males were in the auditory condition and the other half were in the visual condition. Within each condition both the preselected side (left or right) and the order of presentation were used: A) high, low, medium, B) medium, high, low, and C) low, medium, high. These were chosen to insure that each intensity appeared equally in first, second, and third position.

Results

If an infant learned to fixate the appropriate circle due to reinforcement on that side, looking to the nonrewarded side during any conditioning period should be less frequent than they were during baseline. The learning score was thus the number of looks to the nonreward side in the base period minus the number in the conditioning period.

An analysis of variance of the learning score was performed in a 2x2x3x3 design which included, respectively, 1) the modality of reinforcement, 2) the sex of the subject, 3) the intensity of the reinforcement, and 4) the order of the intensities. Two significant F ratios were found. The interaction of order and intensity was significant ($F=3.93$, $df= 4/72$, $p < .01$). The other significant finding was the four way interaction of sex by modality by intensity by order ($F=3.99$, $df=4/72$, $p < .01$). The main effect of modality reached the $p < .10$ level with both sexes learning better under visual than under auditory reinforcement.

In order to better assess the four way interaction, the mean learning score for each sex under the appropriate reinforcements, orders, and intensities was tabulated and is presented in Table 1.

Insert Table 1 about here

In the context of this general interaction, it is of interest to point out that if we look only at sequence B where the medium intensity came on first, we have a small replication of what Watson found in his previous study. Here the learning score for females under auditory reinforcement is 8.00 while under visual it is 0.00. The scores for males under auditory reinforcement is -1.75 and under visual it is 5.75. Taken alone, these results would confirm the earlier finding that girls learn under auditory reinforcement but not visual and boys learn under visual reinforcement but not auditory. Yet there are other instances where the same medium intensity had almost opposite effects. When the medium auditory intensity was second in the sequence for females it was accompanied by negative learning scores; the females looked the other way. On the other hand, when the medium visual intensity was second, it produced the highest of all learning scores for the females (10.50).

For males the changes are not so dramatic but are still there. When medium auditory was second, a positive learning score of 2.00 was obtained and when medium visual was last it produced a lower score (2.75) than when it was first.

The sequences that produced the greatest amount of total learning are the same for both sexes. The best sequence under visual reinforcement is C (low, medium, high) and the best under auditory reinforcement is B (medium, high, low). The patterns within each sequence are quite different though for females and males.

The intensity by order interaction is shown in figure 1.

Insert figure 1 about here

Both the low and the high intensities produced negative learning scores when they appeared as the first intensity in a series. The greatest learning scores were produced by the high intensity when it was second or third in the series.

Discussion

The results of this study indicate that infant learning is a complex issue. The two significant findings reported are an order by intensity interaction, and an interaction of sex, modality order and intensity. Thus, one implication of this experiment is that much of the existing infant learning data should probably be accepted only with respect to the context in which they occurred. We must ask if the results are dependent on the particular situation, such as the intensity used for a stimulus reinforcer or the order in which certain reinforcements appeared.

For example, the previous study by Watson reported that duration of reinforcement had different effects dependent on the modality of reinforcement. A three second reinforcement aided auditory learning and continuous reinforcement was best for learning under visual stimulation. Since this experiment used only the three second reinforcement, this might have affected the results; but considering that both sexes tended to learn better under visual than under auditory reinforcement, perhaps it indicates that the duration variable is valid when only the medium intensity is used. It seems likely that if we had included duration of reinforcement as a variable, we might well have found a five way interaction!

The results of this experiment leave little doubt that previously reported sex by modality interaction is dependent on intensity and order of intensity of the reinforcement stimulation. The learning scores of these 14-week-old's also make it very clear that the young human infant is quite sensitive to differences in the intensity and sequence of reinforcement stimulation as these occur within the "normal range" of auditory and visual stimulation.

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1. This research was supported in part by post doctoral grants given by the University of California, Berkeley to the first and last authors. An earlier version of this paper was presented at the biennial meeting of the Society for Research in Child Development, Minneapolis, Minnesota, 1971.

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Table 1

Mean Learning Scores Under Three Intensities of Auditory and Visual Reinforcement

		Female Intensity			Male Intensity		
	Order	Low	Med.	High	Low	Med.	High
Auditory	H,L,M	-.75	3.75	8.00	1.75	-1.75	-8.75
	M,H,L	2.25	8.00	6.25	2.75	-1.75	4.75
	L,M,H	1.75	-1.75	3.75	-10.00	2.00	-1.00
Visual	H,L,M	4.75	3.75	2.25	3.75	2.75	.25
	M,H,L	1.25	0.00	.75	.75	5.75	8.25
	L,M,H	-3.75	10.50	9.00	7.00	4.00	7.75

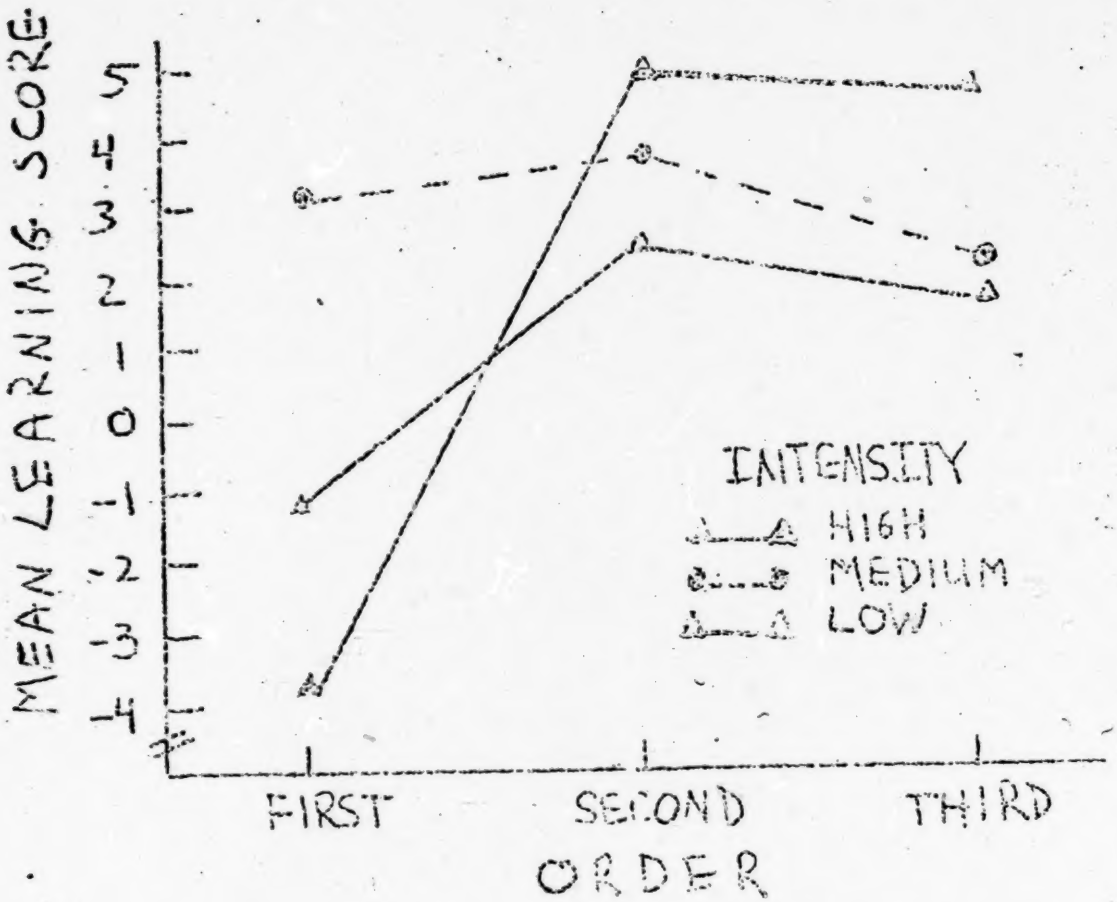

Fig. 1. Mean learning scores for each intensity in each of three positions.